EDI Diffusion Mechanisms and IT-based Strategies for Wholesale Business

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INTRODUCTION

Electronic Data Interchange (EDI) is an innovation tool that changes the buyer-seller relationship and improves supply chain management. The innovation has two important stages called adoption and diffusion (Rogers, 1983). Previous papers suggest that the most influential factor in EDI adoption is competitive pressure from trading partners (Premkumar, 1994, 1995, 1997; Iacovou et al., 1995). Proactive adoption leads to better benefits from EDI than reactive adoption. In an EDI diffusion stage, there are two types of diffusion called internal and external, and both are indispensable to achieve full benefits from EDI.

This paper focuses on the stages of EDI diffusion. Factors that affect the benefits of EDI in proactive and reactive firms will be analyzed separately. The analysis includes external and internal diffusion factors,

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Key Words : EDI diffusion, IT investment, Wholesalers

and new factors associated with IT (Information Technology) investment and the power phenomenon are also analyzed.

THEORETICAL BACKGROUND

EDI is a theoretical and practical subset of Inter-organizational systems (IOS). In the 1980s, most EDI and IOS research stressed the achievement of competitive advantages through IT. Typical examples were Computerized Reservation Systems (CRS) for airline businesses or the ASAP system[1]. In the 1990s, when EDI systems were being introduced to different industries, issues became more complex. Researchers needed to consider various factors and to build comprehensive models. The competitive advantages were not sustainable through EDI systems (Swatman et al., 1992). EDI was not only a competitive weapon but also a competitive necessity (Benjamin et al., 1990). Perceived benefits from EDI differ between proactive and reactive firms (Swatman et al., 1992, 1994; Premkumar et al., 1995, 1997). It, therefore, became important to define the differences that characterize the various aspects of EDI systems used by firms, specifically, whether the firms implement EDI systems proactively or reactively. One theory was not sufficient to explain the issues. Several theories have been used to construct empirical models.

This study analyzes 184 EDI papers[2] published mainly in the United States from 1980 to 1999. All cited works are summarized. The results indicate that the following four theories and their authors dominated the EDI research:

(1) Competitive Strategy, M.E. Porter

1) See Harvard Business School (1985), Venkatraman and Short (1990).
2) The next table shows the top 15 journals from which 184 papers were obtained.

(2) Innovation Theory, E. M. Rogers

(3) Transaction Cost Theory, O.E. Williamson

(4) Marketing Channel Theory, L.W. Stern

(1) Competitive Strategy

Fifty-one[3] of the 184 papers referred to Porter's theory (Porter 1980). Porter says that the state of competition depends on five competitive forces, which are (1)bargaining power of suppliers, (2)bargaining power of customers, (3)threat of new entrants, (4)threat of substitute products or services, and (5)positioning of traditional intra-industry rivals. Porter's concept originates with the theory of industrial organization, and it applies well to EDI research. IOS, including EDI, can change the balance of power in buyer-seller relationships and provide

Full source title	Extracted
European Journal Of Information Systems	11
Transportation Journal	11
Information & Management	9
Journal Of Systems Management	9
Journal Of Strategic Information Systems	8
Library Acquisitions-practice And Theory	7
International Journal Of Information Management	6
Interlending & Document Supply	6
Mis Quarterly	6
International Journal Of Technology Management	4
Information Systems Journal	4
Journal of Management Information Systems	4
Hospitals	4
Management Science	4
Program-electronic Library And Information Systems	4

3) One paper may refer to several papers by the same researcher. In such cases, we counted the numbers respectively.

entry and exit barriers (Cash et al., 1985). Benjamin et al. (1990) insist that as EDI standards become more widespread, the balance of power will shift in favor of the customer, and, consequently, buyers will be the dominant force. Suppliers will promote EDI only when they see it as a way to differentiate themselves from other suppliers. Our name for this hypothesis is "Power Shift to the Customer." The lock-in effect in supplier-buyer connections and the lockout effect of competitors are the key factors of competitive advantage. Thus, Porter's theory explains hostile transaction behavior among transaction partners. But the limitation is that it does not deal with cooperative behaviors.

(2) Innovation Theory

Twenty-four of the 184 papers referred to Rogers' innovation theory. As mentioned above, innovation has adoption and diffusion stages. Rogers (1983, 1995) states that relative advantage, complexity, compatibility, and cost are the key characteristics affecting innovation.

Premkumar et al. (1994, 1995, 1997) built an integrated model including Rogers' innovation characteristics, as well as the environmental characteristics of climate, net-dependence, competitive pressure, and customer support. Furthermore, Premkumar added organizational characteristics, such as top management support, product champion, and size, and found that the differences between adopters and non-adopters are competitive pressure, customer support, organizational size, and top management support. He concluded that external environmental factors, especially competitive pressure, have a greater influence on EDI adoption than any other factors. Similarly, Iacovou et al. (1995) identified perceived benefits, organizational readiness, and external pressure as key factors for small businesses. Iacovou said that external pres-

sure is a major reason that small companies adopt EDI systems. Furthermore, he said that both high organizational readiness and an awareness of the benefits were required for building high-impact EDI systems.

According to the strength of competitive pressure, firms adopting EDI are of two types, proactive and reactive. Premkumar et al. (1995) found that proactive firms tried harder to expand external connectivity with trading partners and integrated internal IS applications. As a result, proactive firms can obtain more benefits from EDI than reactive firms.

In the diffusion stage, factors that facilitate EDI systems have been investigated, too. Ramamurthy et al. (1995) constructed a comprehensive model that included innovation factors in a manner similar to Premkumar et al. With organizational factors including top management support, IS sophistication, and championing, and organizational learning with elapsed time since initial adoption, they concluded that:

(a) Compatibility of technical and organizational elements and the learning process were key dimensions of internal and external diffusion;

(b) Relative advantage, scope for EDI mode, and championing for EDI were also important factors for internal diffusion; and

(c) Top management support was the only additional determinant of external diffusion.

Ramamurthy's investigation indicated that the impact of Rogers' innovation factors was not as strong as he expected in EDI diffusion. Therefore, researchers tried to find the key determinants of EDI diffusion. They found that external expansion of transaction partners, transaction sets, and internal integration of IS applications are important factors to show the level of the diffusion process (Swatman et al., 1992, 1994;

Mukhopadhyay et al., 1993; Sokol, 1989; O'Callaghan et al., 1992; Riggins et al., 1994).

(3) Transaction Cost Theory

Twenty-three of the 184 papers cited Williamson's transaction cost theory. IOS studies have referred to his theory to analyze the impact of IT on the structure of markets and hierarchies (Srinivasan et al., 1994). Malone et al. (1987) predicted that IT would lead an overall shift toward proportionally more use of markets rather than hierarchies because IT can reduce the costs of coordination. The hypothesis is called "Move to Market." In contrast, Clemons et al. (1993) proposed a hypothesis called "Move to the Middle." He insisted that a greater degree of outsourcing would take place and serve as intermediate governance structures replacing ownership and vertical integration. Moreover, Venkatraman et al. (1990) found that electronic integration had a positive effect on increased performance efficiency; however, it proved to be ineffective. Prosser et al. (1997) defined "open" and "closed" EDI systems. They concluded that open EDI furthers market coordination by reducing asset specificity and by making additional partners available. Williamson's transaction cost model uses markets and hierarchies to determine governance structure. A more precise summary of EDI studies follows.

(a) Uncertainty and Bounded Rationality

Bensaou et al. (1996) reviewed theoretical EDI studies and argued that the contingent fit between information processing needs, which includes environmental, partnership, and task uncertainties, and information processing capability, which includes structure, process, and IT-mediated mechanisms, were important in order to achieve higher performance through EDI. Bensaou (1997) applied aspects of this contingency model

and found that inter-organizational cooperation, considered a dependent variable, was more strongly affected by transaction climate, which includes cooperation or conflict, than by structural or technological factors.

(b) Opportunistic Behavior and the Number of Suppliers

Williamson says that opportunistic behavior increases when the number of trading partners shrinks. Since EDI might reduce the number of suppliers, the probability of opportunistic behavior increases. However, detrimental effects arising from a smaller number of suppliers might be alleviated by advantages created by the trust that is established among long-term trading partners. EDI has the potential to contribute to mutual trust between trading partners. Just In Time (JIT) management is a typical example. It is indispensable to select trustworthy suppliers in order to achieve an efficient and effective JIT operation. Therefore, JIT and EDI strategies may take place simultaneously (Hart et al., 1997). In a "Move to the Middle" situation, firms will also rely on a reduced number of suppliers, and they will invariably choose suppliers with whom they have close and long-term relationships (Clemons et al., 1993). In such cases involving EDI partnerships, a small number of trading partners does not lead to opportunistic behaviors, because such partnerships are based on mutual trust.

(4) Marketing Channel Theory

Twenty-five of the 184 papers referred to Stern's marketing channel theory. It contributes to EDI studies when power phenomena between buyers and sellers are explicitly considered. EDI studies have focused on how initiators, such as firms that have an EDI power base, exert competitive pressure on followers or those firms that do not have an EDI power

base. Because EDI systems are regarded as transaction-specific assets that result in resource dependency, Williamson's perspective is sometimes used in conjunction with others to treat issues dealing with power. Williamson (1981) explains asset specificity as follows:

Asset specificity is both the most important dimension for describing transactions and the most neglected attribute in prior studies of organization ..... Items that are unspecialized among users pose few hazards since buyers in these circumstances can easily turn to alternative sources and suppliers can sell output intended for one buyer to other buyers without difficulty. Marketability problems arise when the specific identity of the parties has important cost-bearing consequences. Transactions of this kind may be referred to as idiosyncratic.

O'Callaghan et al. (1992) argued that if initiators want to continue to hold the share benefits of EDI, it is important to design a technically idiosyncratic system and require significant investment in system-specific human capital. Hart et al. (1997) insisted that the probability of building trust is greater when persuasion is used instead of coercion.

Investments in EDI build relation-specific assets. EDI resources can themselves form a power base because they result in a system and/or an information asymmetry that can be described as interdependency among trading partners. A relation-specific EDI system (i. e. an idiosyncratic or proprietary system), establishes a power structure based on resource dependency, while a standardized EDI system, such as an industry-wide open system, gives every firm the potential to become a leader because of fast growth opportunities. Sasaki (1999) explains the EDI power transition mechanism as follows:

(a) Financial power is transferred to an EDI power base through IT investment.

(b) Initiators exert power in two ways:

(i) Initiators coercively force followers to build EDI systems. In this situation, standardized systems are selected. Customers sometimes use this strategy to reduce costs associated with switching and, therefore, obtain flexibility to change suppliers.

(ii) Initiators persuasively help followers build EDI systems. In this situation, relation-specific systems are selected. Suppliers sometimes use this strategy to strengthen the bonds with their customers.

(c) The power structure between two partners is fixed. Especially, in this case b(ii), resource dependency is strengthened.

(d) In both of the following cases, initiators ultimately fail to maintain their power:

(i) Failure of lock-out strategy: Initiators lose power when followers succeed in building their own EDI systems. They easily make connections with their initiator's rivals because the system is standardized.

(ii) Failure of lock-in strategy: Initiators lose dominance in the industry because the systems are relation-specific; and, therefore, they are unable to achieve a critical mass.

The exception is the strong firm that succeeds in expanding its own system beyond critical mass, or one that obtains a standard position among its peers. Though this is a desirable process from the viewpoint of network externalities, few firms achieve it because of rivalry or great dependency on trading partners. With a viewpoint of marketing channel theory, dependency on partners is an important factor that affects EDI diffusion.

(5) Summary

The stream of empirical research on EDI suggests that the key issues for an EDI diffusion strategy are as follows:

(a) Whether a firm builds an EDI system proactively or reactively,

(b) Whether a firm expands its transaction partnerships or transaction sets externally or whether it integrates IS applications internally,

(c) Whether a firm invests in relation-specific or standardized systems.

Further research is needed on the diffusion stage. Though previous research suggests that competitive pressure is the most important factor in the adoption stage and that proactive firms may achieve greater benefits than reactive firms, there is a possibility that reactive firms, even unwillingly, may also obtain benefits that are nearly equal to those obtained by proactive firms provided that they are able to gradually expand the number of their trading partners or transaction sets. From this point of view, the difference in diffusion between proactive and reactive firms should be investigated. Also to be explored is the fact that though EDI adoption and/or diffusion are related to decision making for IT investment, the relationships between IT investment and EDI diffusion have not been discussed explicitly. Still another avenue for further study is the power phenomenon, or resource dependency between partners, which is an important factor because it can restrict EDI diffusion in terms of negative network externalities (Riggins et al., 1994). However, the dependency level between partners has not been considered in empirical models.

In this paper, firms are divided into proactive and reactive groups in order to understand the significant variables that increase benefits in the diffusion stage, which includes (a)IT investment factors and (b)the

level of dependency between partners.

HYPOTHESIS AND MODEL BUILDING

Riggins et al. (1994) classified firms as initiators or followers. The initiators are the firms that initiate EDI systems by strongly encouraging their trading partners. The followers are the firms that adopt EDI as a result of external pressure. This is true of the first adoption stage, but it is more complex in the diffusion stage. For example, some followers may act as initiators when dealing with firms that have not accepted the innovation, or some firms may no longer feel competitive pressure because they have established EDI systems with their dominant partners. Therefore, we define proactive and reactive firms, instead of using the term initiator or follower:

(1) Proactive firms build EDI systems under low competitive pressure.

(2) Reactive firms build EDI systems under high competitive pressure.

Several common indicators affecting both proactive and reactive firms that are trying to obtain increased benefits from EDI systems are discussed below.

First, diffusion is the most important process for both firms. Firms have several options to facilitate EDI systems. Namely, firms that externally expand their numbers of transaction partners or transaction sets and internally integrate Information Systems (IS) can obtain full benefits from EDI systems. Proactive firms are more willing to expand their numbers of transaction partners, at least from the viewpoint of network externalities, than are reactive firms, which are sometimes reluctant to externally expand the number of partners. For example, if a firm's inventory management lacks sophistication, the larger the number of trading partners, the more complicated the internal

operation becomes. As a result, a firm would not have any incentive to increase its number of partners.

H1: Higher benefits from EDI. The expansion of partners is more favorable for proactive firms than it is for reactive firms when EDI diffusion is taking place.

Furthermore, reactive firms are under competitive environmental pressure. After first being adopted by a partner, the partner, who is sometimes a strong initiator, tends to force a firm to add another transaction set. This situation occurs more frequently in reactive firms. Besides, reactive firms have little choice but to accept relation-specific systems from initiators. The best way for reactive firms to obtain higher benefit is to expand the number of transaction sets with a limited number of EDI partners. Previous research indicates that IS readiness is important in the diffusion stage (Ramamurthy et al., 1995). Since the expansion of transaction sets requires internal IS readiness, it can be used as an indicator to measure the internal diffusion level, though it is sometimes applied to measure the external diffusion level. Therefore, it is assumed that proactive firms tend to expand externally (H1), and reactive firms tend to expand their numbers of transaction sets (H2). The difference determines whether the application of EDI diffusion will achieve higher benefits.

H2: Higher benefits from EDI. The expansion of the number of transaction sets has a more positive effect on reactive firms than it does on proactive firms in the EDI diffusion process.

As already reported, the value of mutual trust between trading partners is important. When EDI partnerships lead to small numbers (Williamson, 1975), the dependency level between trading partners increases. It is especially true that the level of dependency will strengthen when an EDI system is relation-specific. However, some firms use coercion to force partners to build standardized systems. It is assumed that dependency levels affect reactive firms more positively because the only strategic option they have to obtain higher benefits is to build relation-specific systems.

H3: Higher benefits from EDI. Reactive firms achieve greater benefits from a dependency level than do proactive firms in the EDI diffusion process.

As already reviewed, innovation factors do not have a strong influence on EDI adoption or diffusion processes; therefore, innovation characteristics are not used explicitly. As for organizational factors, previous research has shown that top management support affects EDI diffusion (Premkumar, 1995). To measure this factor, we use the amount of IT investments because IT investments directly reflect top management support. It is assumed that proactive firms are more positive in IT investments than reactive firms because top management enthusiasm has a greater effect in proactive firms.

H4: Higher benefits from EDI. IT investments are higher in proactive firms than in reactive firms in the EDI diffusion process.

Several methods are used to evaluate IT proposals. Cost benefit and

business process analysis are typical examples. As EDI diffusion proceeds, IT investment proposals become more complicated. As a result, firms should use several methods to more effectively evaluate and prioritize proposals. We suppose there is a difference in how strictly the proactive and reactive firms adhere to the methods used for evaluation and prioritization. Reactive firms try to estimate these proposals more strictly because top management is reluctant to invest in EDI projects. An unwavering adherence to methodology can determine the benefits to be received, and the reactive firms are more likely to benefit from strict adherence than are the proactive firms.

H5: Higher benefits from EDI. Strict adherence to investment controls is more suitable for reactive firms than for proactive firms in the EDI diffusion process.

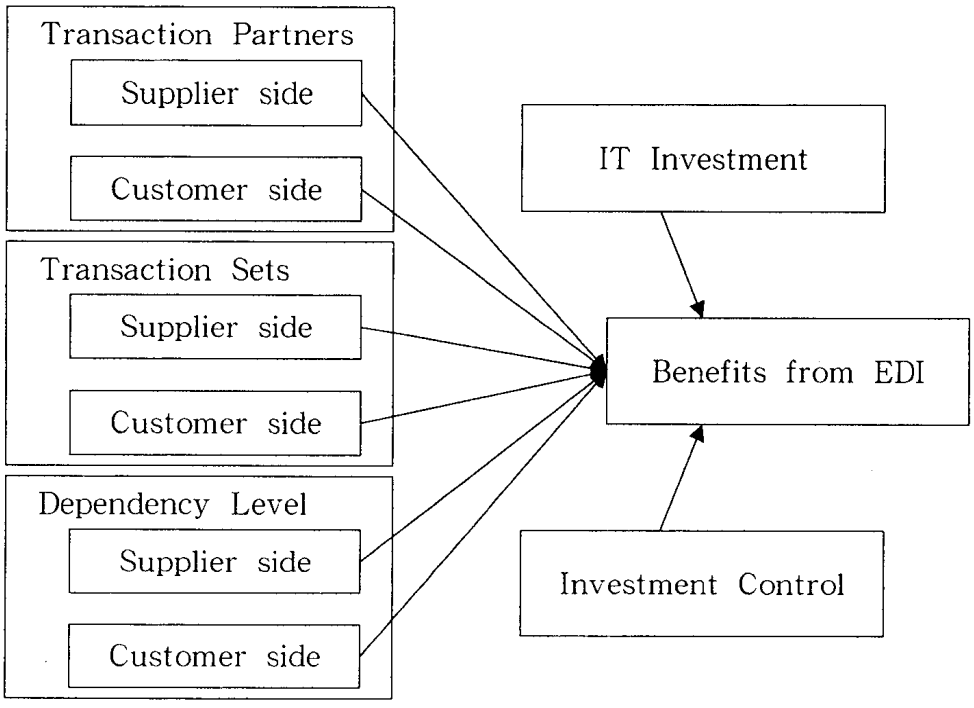

Fig. 1 Research Model

Figure 1 shows the model as it is applied separately to proactive and reactive firms to reveal the differences between the two.

RESEARCH METHODOLOGY

(1) Survey Plan

The focus is on wholesale industry in the United States. There are several reasons for selecting the wholesale business. It is in the middle of the supply chain consisting of manufacturers, wholesalers, and retailers. It also is based on business-to-business (B-to-B) connections involving both the supplier and the buyer, and the business-to-customer connection can be omitted. Furthermore, since the business of a wholesaler is distribution, EDI can be a critical success factor. Fifty firms were selected according to their sales volume from among each of the 4-digit Standard Industrial Classification (SIC) codes used for a mailing survey.

(2) Variables

(a) EDI Adoption

Firms are asked if they use an EDI system with suppliers or customers. They are asked individually to answer questions that may be answered by yes or no. Depending on their answers, the respondents are divided into the following three groups: adopters with suppliers, adopters with customers, and adopters with suppliers and customers.

(b) Competitive Pressure

The following two questions are asked: (1)Do suppliers force the focal firm to develop EDI systems? And (2)Do customers force the focal firm to develop EDI systems? Both questions may be answered on a 1-5 scale. One is "completely disagree," and five is "completely agree." The

answers reveal whether a firm is proactive or reactive.

(c) Benefits (Dependent Variable)

This variable has five items: "Cost Reduction," "Inventory Management," "Closer Relationships Between Suppliers and Customers," "Business Process Reengineering," and "Learning and Growth." These items are measured on a 1-5 scale. One is "not important," and 5 is "important." R. S. Kaplan's "Balanced Score Card" concept was used for the construction of the variable. These items correspond to Kaplan's "Financial Perspective," "Internal Perspective," "Customer Perspective," and "Innovation and Learning Perspective."

(b) EDI Diffusion

*Partners

To measure external diffusion, the percentages are collected of all suppliers and customers who use EDI. Their answers are measured in percentiles of 20 (0-20%, 21-40%, 41-60%, 61-80%, and 81-100%).

*Transaction Sets

A variety of transaction sets is collected to measure the internal diffusion level. Our questionnaires are constructed as follows. Each diffusion level is calculated by adding the "Yes" answers, which have a range of 0-4.

(i) On the supplier side, what does your company use EDI for?
For orders; Yes/No
For reports of orders; Yes/No
For payments; Yes/No
For exchanging inventory information; Yes/No

(ii) On the customer side, what does your company use EDI for?
For receiving orders; Yes/No
For reports of orders; Yes/No

For payments; Yes/No

For exchanging inventory information; Yes/No

(e) Dependency Level

The dependency level is measured by computing the percentage of purchases from the most important supplier and comparing the number to total purchases. In the same manner, the percentage of sales to the most important customer is compared to total sales. Both numbers are used to measure the dependency level. These items are measured on a percentile basis (25% under, 25%-49%, 50%-74%, 75-99%, and 100%).

(f) IT Investments

IT investments are used as a percentage of annual sales to adjust for bias due to the size of a firm.

(g) Evaluation of IT Investments

The methods to evaluate IT-investment proposals are gathered. They are composed by six items: "Cost Benefit Analysis," "Cash Flow," "Return on Investment (ROI)", "Net Present Value (NPV)", "Weighted Scoring", and "Business Process Analysis". All questions may be answered by "yes" or "no" (1/0). This variable is calculated by the sum of "yes" answers with a range of 0-6.

RESULTS

(1) Summary of the Survey

The survey was sent to 3,450 wholesalers in the United States (50*69 sic codes=3,450) on July 5, 1999. By early September, we had received 209 usable responses. The response rate was less than 10% because many on the mailing list had probably not adopted EDI systems.

(a) EDI Adoption

A total of 149 (32+32+85; 71%) firms use EDI with either suppliers or

			EDI (C)		Total
			No	Yes	
EDI(S)	No	Count	60	32	92
		% of Total	28.7%	15.3%	44.0%
	Yes	Count	32	85	117
		% of Total	15.3%	40.7%	56.0%
Total		Count	92	117	209
		% of Total	44.0%	56.0%	100.0%

Fig. 2 EDI Adopters / Non-adopters

customers, and 85 (40.7%) firms use EDI with both suppliers and customers (Fig. 2).

(b) Competitive Pressure

Figure 3 shows the tendency of competitive pressure from both the supplier and the customer. This distribution shows all the respondents, including those who do not use EDI. The correlation between both sides is insignificant (0.111). All non-adopters are excluded, and the firms are defined in the P area of Fig. 3 as "proactive firms." Firms in the R area

Count

		EDI(C)					Total
		Completely disagree	Disagree	Neutral	Agree	Completely agree	
EDI(S)	Completely disagree	16	3	3	5	11	38
	Disagree	P 6	14	11	8	7	46
	Neutral	7	2	29	R 9	7	54
	Agree	11	10	8	13	9	51
	Completely agree	R 2	3	3	5	6	19
Total		42	32	54	40	40	208

EDI (S) : Suppliers force the focal firm to develop EDI systems
EDI (C) : Customers force the focal firm to develop EDI systems
Peason's R : 0.111

Fig. 3 Competitive Pressure

are "reactive firms."

(c) Benefits of EDI

"Closer Relationships," "Cost Reduction," and "Inventory Management" are relatively important factors (Fig. 4-A). Principal com-

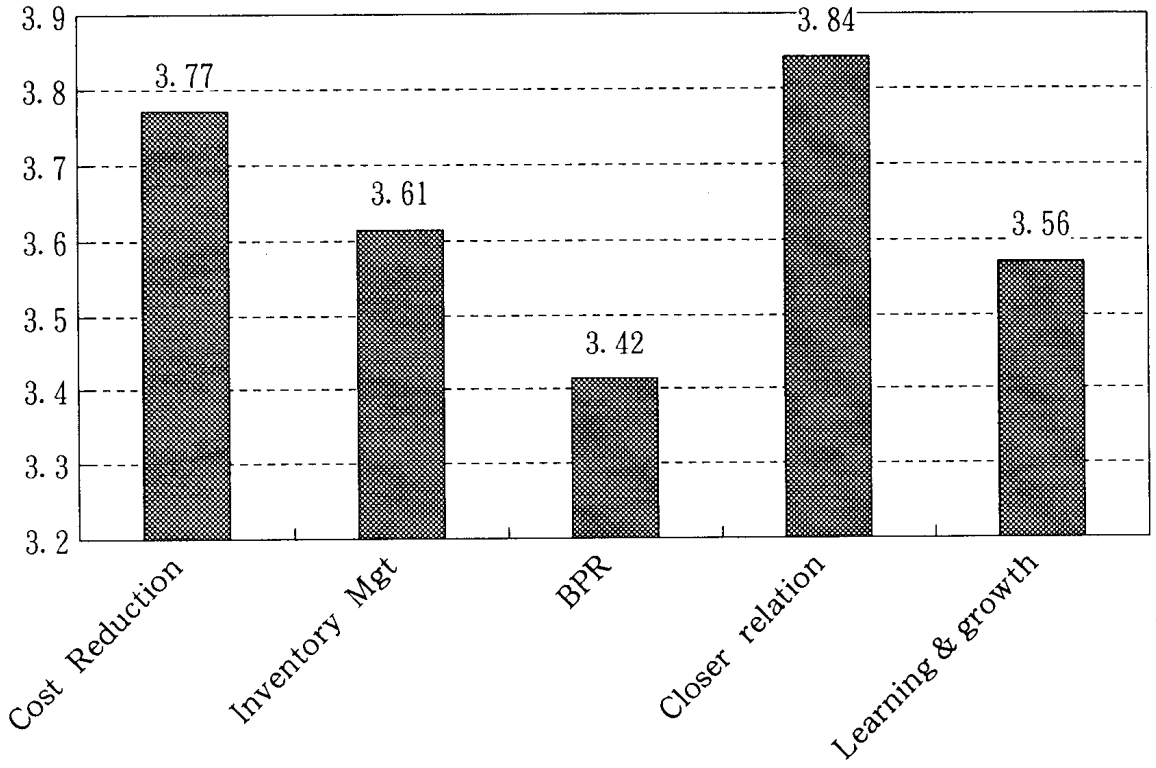

Fig. 4 - A Benefits of EDI

Component	Total	% of Var	Cumulative %	Total	% of Var	Cumulative %
Factor 1	2.91	58.11	58.11	2.91	58.11	58.11
Factor 2	0.80	15.93	74.05			
Factor 3	0.50	10.01	84.06			
Factor 4	0.42	8.46	92.51			
Factor 5	0.37	7.49	100.00			

Fig. 4 - B The Result of Principal Component Analysis

ponent analysis and Cronbach's Alfa were used to test the validity and reliability of the components. As a result, only one factor was extracted

(Fig. 4-B), and Cronbach's Alfa was 0.891. The validity and reliability are both adequate. The factor score is defined as a dependent variable.

(d) Diffusion

Figure 5-A shows the external diffusion of partners on the supplier and the customer sides. The correlation between the two was strong and significant (0.447**).

As for transaction sets, most adopters use EDI in the following order of importance, "Processing Orders," "Reports of Orders," "Payment,"

Count

	Partner (C)					Total
	0-20%	21-40%	41-60%	61-80%	81-100%	
Partner (S) 0-20%	34	2	3	1	2	42
21-40%	4	3	3			10
41-60%	2	1	4		1	8
61-80%	3	1	3	2	1	10
81-100%	3	2			4	9
Total	46	9	13	3	8	79

Peason's R : 0.447**

Fig. 5 – A The External Diffusion

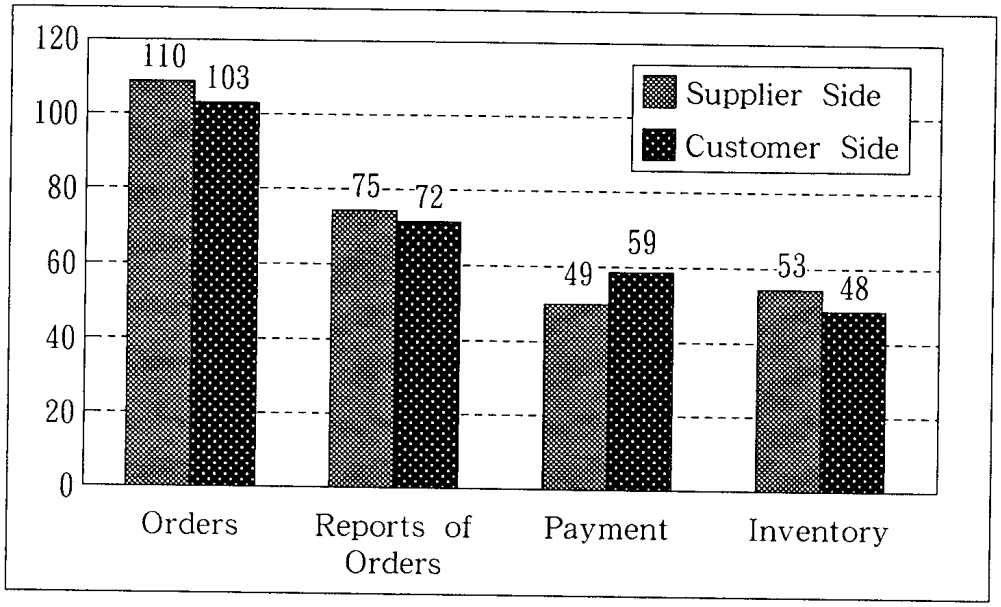

Fig. 5 – B Transaction Sets

and "Exchange Inventory Information" (Fig. 5-B). Except for "Payment," suppliers use EDI more frequently than do customers. The transaction set variable is defined as follows:

Supplier side: Transet(s) = Orders*(S) + Reports of Orders*(S) + Payment*(S) + Exchange Inventory Information*(S)

Customer side: Transet(c) = Orders*(C) + Reports of Orders*(C) + Payment*(C) + Exchange Inventory Information: (C)

(* All items are 1/0.)

(e) Dependency Level

The next cross tabulation shows the dependency level on both the supplier and the customer sides (Fig. 6). On both sides, 49.76% of all the respondents answered "25% under." The correlation between the two was significant but not too strong (0.212**).

(f) IT Investments

The mean value of IT investments as a percentage of annual sales was 1.8%. Figure 7 shows the distribution.

			Dependency (C)				Total
			25% under	26-49%	50%-74%	75%-99%	
Dependency (S)	25% under	Count	103	10	3	1	117
		% of Total	49.76	4.83	1.45	0.48	56.52
	26-49%	Count	25	9	1	1	36
		% of Total	12.08	4.35	0.48	0.48	17.39
	50%-74%	Count	17	3	2	1	23
		% of Total	8.21	1.45	0.97	0.48	11.11
	75%-99%	Count	18	4	1	4	27
		% of Total	8.70	1.93	0.48	1.93	13.04
	100%	Count	4				4
		% of Total	1.93				1.93

Peason's R : 0.212**

Fig. 6 Dependency Level

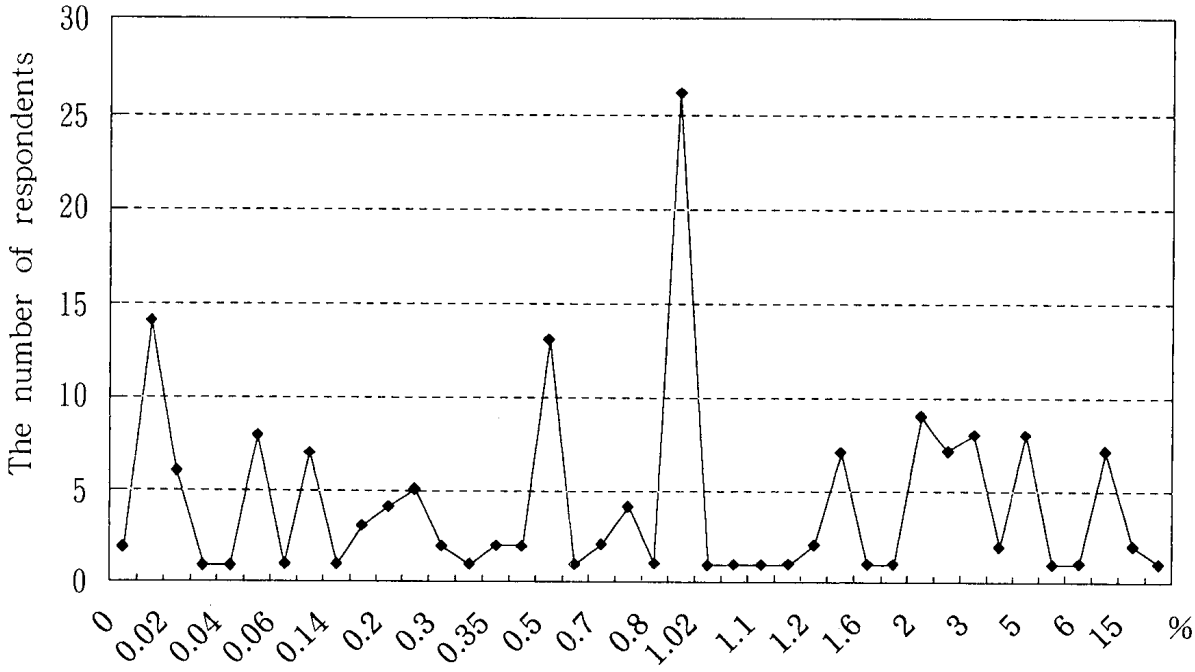

Fig. 7 IT Investments

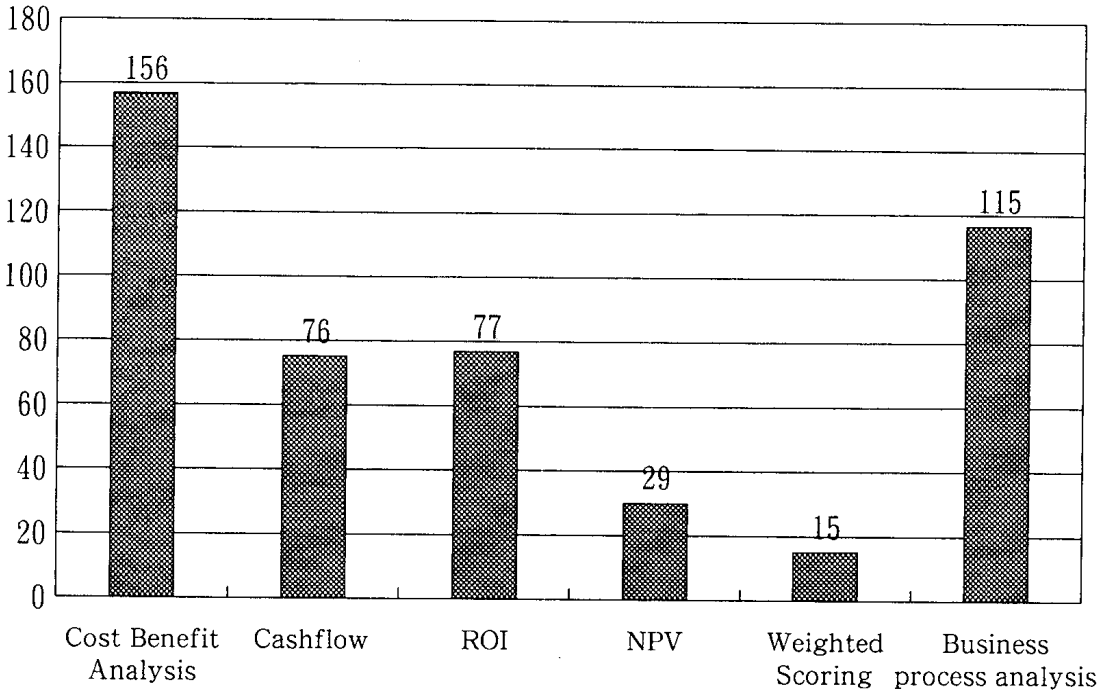

Fig. 8 Methods to evaluate IT Investment

(g) Control (The Evaluation of IT Investment)

Figure 8 shows tendencies of the original variables. The popular methods to evaluate IT investment proposals are "Cost Benefit

Analysis" (158; 87.2%) and "Business Process Analysis" (115; 64.2%). About 40% of the companies also use "Cash Flow" or "ROI." The variable "Control" is defined as follows:

CONTROL=Cost Benefit Analysis*+Cash Flow*+ROI*+NPV*+Weighted Scoring*+Business Process Analysis* (* All of the items are 1/0.)

(2) Covariance Structure Analysis

Covariance structure analysis was conducted to test the hypotheses. The Comparative Fit Index (CFI) and Incremental Fit Index (IFI) were used to test the fitness of the model. In the process of seeking a better fit, the model was appropriately changed as described in the following:

(a) Covariance

Using all valid data, correlation analysis was performed. The correlation of Transet (S/C 0.541**) between the supplier and the customer sides, and the correlation of Partners between the two (S/C 0.447**) were strong. The correlation of Dependency level in the proactive model was also strong (S/C 0.45**). Therefore, three double-headed arrows (covariance) were added to each model to obtain a better fit.

(b) The Missing Values

The number in the sample is small when the sample is divided into proactive and reactive groups. Therefore, the missing values were replaced with the average value for each variable.

The following two figures show proactive model results (Fig. 9-P; CFI=0.899, IFI=0.903) and reactive model results (Fig. 9-R; CFI=0.961, IFI=0.962). All CFIs and IFIs are close to 1.0, which indicates a good model fit.

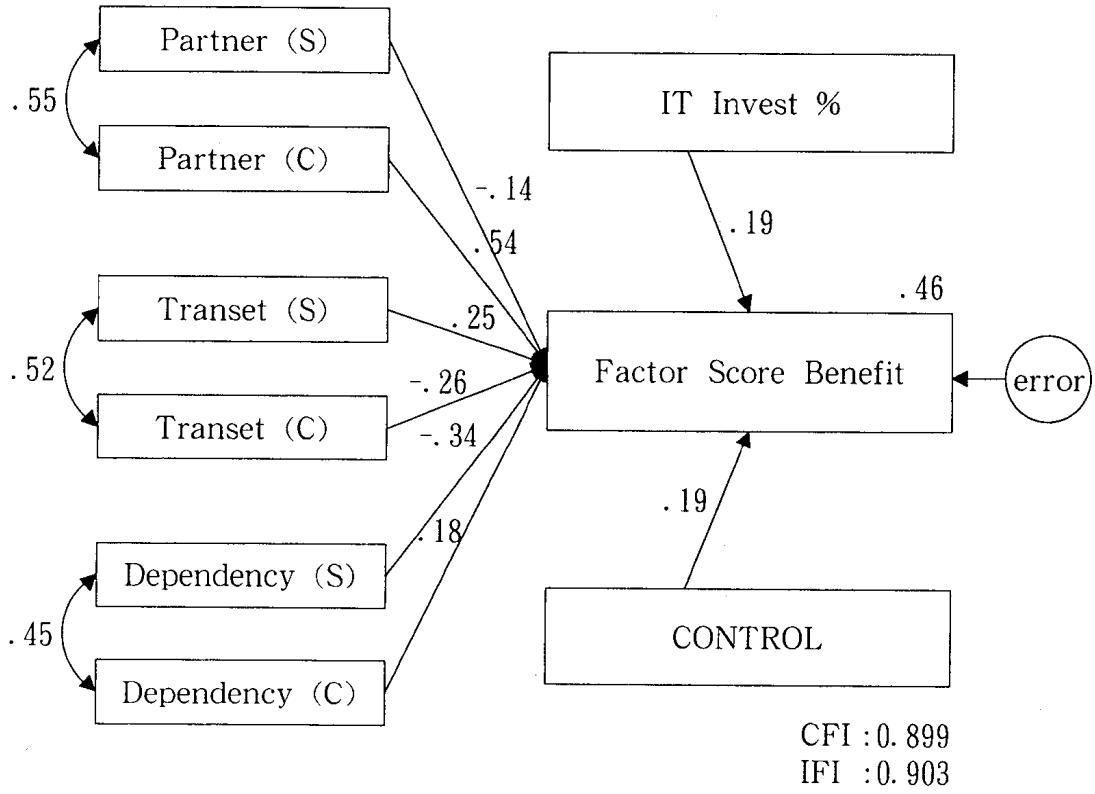

Fig. 9－P Proactive Model

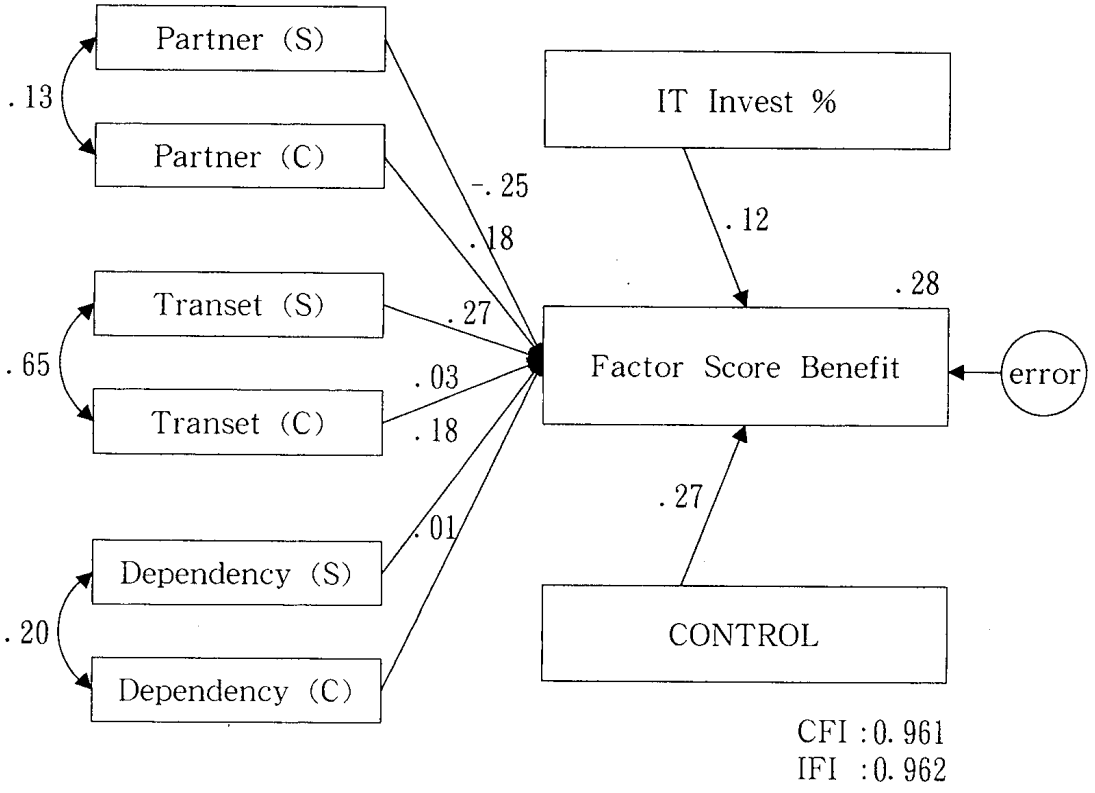

Fig. 9－R Reactive Model

(3) Results of Covariant Structure Analysis

(a) Proactive Model

There is a difference in the factors for achieving higher benefits between the supplier and customer sides.

(P-S) Supplier Side

The expansion of transaction sets on the supplier side is important (Transet(S): 0.25), but the external diffusion of partners and the dependency level have a negative effect (Partner(S): -0.14, Dependency (S): -0.34).

(P-C) Customer Side

The expansion of trading partners (Partner(C): 0.54) is the most important factor. The dependency level has a less positive effect than the expansion of trading partners (Dependency(C): 0.18), while transaction sets, on the contrary, have a negative effect (Transet(C): -0.26).

(P-IT) IT Investment and Control

Positive effects are observed on both IT investment and control (Both 0.19).

(b) Reactive Model

(R-S) Supplier Side

As with the proactive model, the expansion of transaction sets on the supplier side is important (Transet(S): 0.27), and the external diffusion of partners has a negative effect (Partner(S): -0.25). The dependency level has a positive effect, but it is not too strong (Dependency(S): 0.18).

(R-C) Customer Side

The expansion of the trading partners has a positive effect, but it is not too strong (Partners(C): 0.18). Transaction sets and dependency level have very little effect (Transet(C): 0.03, Dependency(C): 0.01).

(R-IT) IT Investment and Control

Positive effects are observed on both IT investment and control. Control has an especially strong effect (IT invest: 0.12, Control: 0.27).

(c) **Hypothesis Testing**

H1: The Expansion of Partners

Only the customer side supports H1. The coefficient in the proactive model is stronger than in the reactive model.

H2: The Expansion of the Transaction Sets

H2 is not supported. On the supplier side, the coefficients of this variable are almost the same as in the proactive model (0.25) and in the reactive model (0.27). However, on the customer side, the coefficients are negative (-0.26) or nearly zero (0.03). The influence of the expansion of transaction sets depends not on whether a firm is proactive or reactive but on whether it is a supplier side or a customer side.

H3: Dependency Level

H3 is not supported. The result was complicated (Fig. 10).

(i) H3-PS: The proactive model on the supplier side has a strong negative effect (-0.34).

(ii) H3-PC&RS: The proactive model on the customer side and the reactive model on the supplier side have positive effects (both 0.18).

(iii) H3-RC: The reactive model on the customer side has no effect (0.01).

H4: IT Investment

The proactive model has a stronger effect than the reactive model

	Supplier side	Customer side
Proactive firm	−	+
Reactive firm	+	0

Fig. 10 Summary of H3

(Proactive 0.19, Reactive 0.12). Therefore, H4 is supported.

H5: Control over IT Investment

The coefficient of the reactive model is stronger than that of the proactive model (Proactive 0.19, Reactive 0.27). Therefore, H5 is supported.

DISCUSSION

The concern was to make clear the difference between proactive and reactive firms. The factors that related to IT investment show the difference. Proactive firms have more positive effect on IT investments as a percentage of annual sales than reactive firms (H4), while reactive firms need to adhere strictly to the IT investment evaluation in order to gain better benefits than proactive firms (H5). The factors related to transaction partners and transaction sets indicate the importance of considering the differences between the supplier and customer sides, which is more significant than whether a mode is proactive or reactive. On the supplier side, firms should add transaction sets and build closer relationships in order to obtain better benefits, while on the customer side, expansion of partnerships is essential. There is a contingent fit between the EDI strategy and EDI diffusion. It is described as follows:

Closed Strategy: On the supplier side, a relation-specific system is suitable for the expansion of transaction sets in an EDI diffusion process.

Open Strategy: On the customer side, a standardized system is suitable for the expansion of trading partners in an EDI diffusion process.

A "Closed Strategy" to suppliers may look inappropriate because this relation-specific asset matches a supplier's differentiation strategy, and it

makes it difficult for wholesalers to switch to other suppliers. However, wholesalers can accept this situation because it helps wholesalers provide goods to customers in a more timely manner; and, furthermore, it helps them manage inventories more accurately. This is why wholesalers are eager to expand transaction sets on the supplier side in the diffusion stage. In order to pose a credible threat of changing suppliers and in order not to exceed the permitted limits of dependency, proactive firms need to maintain a pool of prospective suppliers (H3-PS). In this sense, "Move to the Middle" strategy (Clemons et al., 1993) on the supplier side is appropriate; however, maintenance of interdependency with EDI partners is the only way for reactive partners to facilitate EDI diffusion (H3-RS).

Similarly, an "Open Strategy" for customers may appear unsuitable because it permits customers to switch to other wholesalers without adding expense. A "Power Shift to the Customer" occurs in this situation, but wholesalers also have opportunities to sell their goods to other customers or to switch to more profitable customers. This is why wholesalers try to expand transaction partners on the customer side in the diffusion stage. In this sense, "Move to the Market" (Malone et al., 1997) on the customer side is appropriate. In addition, proactive firms sometimes use lock-in strategies to simultaneously obligate customers (H3-PC).

SUMMARY AND CONCLUSION

The IT investment style affects proactive and reactive firms in the EDI diffusion process. The essence of the IT-based strategy for wholesale business is to reduce the asset specificity on the supplier side and to provide equal opportunity for customers to access all kinds of goods. It

also brings more prosperity to wholesalers themselves.

There are some good examples to explain the results of this study. Retailers in the United States and Japan established EDI standards in the 1980s, and they have forced wholesalers to use their own standards. Wholesalers should act as followers in the adoption stage, but in the diffusion stage, they can get more customers by using EDI if they are willing to act proactively. Even by acting reactively, wholesalers have the potential to connect with other customers because the system is standardized. Because of this, wholesalers must control IT investment strictly in order to gain more benefits.

In another example, a major automobile manufacturer in Japan made use, primarily, of relation-specific systems for JIT operations. Some of the wholesalers who had to form relationships with parts makers on the supplier side as well as car manufacturers on the customer side were forced to use non-standardized EDI systems. If these relation-specific systems were expanded throughout the supply chain, EDI would not be effective for wholesalers according to the findings in this study because they should use a "Closed Strategy" on the customer side. Furthermore, they would have no chance to expand their own customer base over a long period of time. Only in Japan, wholesalers accept this situation where long-term relationships among suppliers and customers take precedence over other circumstances. This relationship is known in Japan as *keiretsu.*

In yet another example, one of the major automobile manufacturers in the United States announced a merger of online procurement systems. The situation was reported in the *Dow Jones Business News* (Feb. 25, 2000). The report states:

The new online supply exchange network will be open to all auto manufacturers and suppliers, creating one of the world's largest virtual marketplaces, a source told the Associated Press. GM, Ford, and Daimler Chrysler will have equal ownership of the venture, which will operate as a separate independent business that could eventually be expanded to include other industries.

Though this is not an example involving wholesalers, the case shows that strong proactive firms can force suppliers to reduce their relation specificity by using standardized EDI systems. The situation is similar to the first example in this section. The three major automobile manufacturers of the United States can expand their pool of suppliers by employing this strategy. However, in order to maintain efficiency in their JIT operations, they must also select trustworthy suppliers. Consequently, it looks like a reshuffling process that would result in a smaller number of more desirable suppliers. Suppliers have the most to gain by using the same strategy as that used by the wholesalers as is discussed above.

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EDI Diffusion Mechanisms and IT-based Strategies for Wholesale Business

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This study is an examination of the differences in management style in Electronic Data Interchange (EDI) diffusion. In advance to this study, we analyzed 184 academic manuscripts and extracted the dominant theories relied on for EDI research. These analyses show that EDI research has been developed by Competitive Strategy (M. E. Porter), Innovation Theory (E. M. Rogers), Transaction Cost Theory (O. E. Williamson), and Marketing Channel Theory (L. W. Stern). We found that further research is needed to make clear the differences between proactive and reactive firms in EDI diffusion. Covariance structure analysis using data from 209 wholesalers in the United States indicates the following: (1) Active Information Technology (IT) investment is important for proactive firms, while strictly adhering to an IT investment plan is important for reactive firms, (2) The expansion of transaction sets and close relationships are crucial on the supply side for both proactive and reactive firms, and (3) The diffusion of transaction partners on the side of the customer for both types is essential. Lastly, we will discuss IT-based strategies for wholesale business.